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DISAGREEMENT AND PUBLIC HEALTH

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1. Introduction

Starting early in the COVID-19 pandemic, government leaders around the world reassured the public that they would "follow the science". This confident statement belied the significant disagreements that lay both within and between the plurality of sciences that comprise public health and inform pandemic response. Economists and infectious disease experts, for example, evaluated the risk/benefit ratio of lockdown measures differently, with the former focused on the harms associated with economic slowdown while the latter regarded economic health as contingent on disease mitigation. Both sides could point to public health as a desired goal but disagreed on how to get there.

Even within the disciplinary factions, there were reasonable grounds for disagreement. There was opposition among epidemiologists regarding the utility of lockdowns (see Ioannidis 2020 versus Lipsitch 2020), and researchers disputed the evidence for masking in non-hospital settings (Science Media Centre 2020). These disagreements often played out on news and social media platforms rather than being confined to the usual academic forums, and, with that publicity, ran the risk of undermining public trust (Cross 2021). Even before the pandemic there had been philosophical disputes over whether transparency about the messiness of the scientific process is a virtue, or if it would lead to more public confusion and apprehension towards science (John 2017). This problem was intensified during the pandemic, when science was happening in real-time and was very much on public display. The public could plainly see that "following the science" was not a straightforward task.

There are many sources of disagreement in public health. Section 2 highlights how disagreements in public health are, at first glance, methodological, but those practical concerns speak to broader epistemological, ethical, and ontological differences within the field and between diverse stakeholders (including the public). Sections 3 and 4 illustrate this layering of scientific, philosophical and social sources of conflict within public health with case studies of the contentious use of epidemic models for disease forecasting (Section 3) and "lockdowns"[1] (Section 4) during the COVID-19 pandemic.

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The standard strategies described by philosophers for managing disagreement are not especially helpful in these public health cases, especially the COVID-19 pandemic case. Consider Christensen's (2007) classic *Dinner Bill* Case. In it, he asks us to imagine a scenario in which friends go out for dinner. At the end of the meal, two of the friends calculate how much each owes. They are equally good at the arithmetic required to undertake the task and they each have access to the same evidence (the bill), but they come up with different numbers. What to do? Standard responses are that we might split the difference or get a third person involved to redo the calculations. Underlying these standard epistemological responses is the sensible assumption that someone has made an error, but we cannot tell from the mere fact of the disagreement who that is and doing things like getting a third party involved makes sense (Sidgwick 1981/1907: 342; Christensen 2007: 342). In public health, and in medical science at the early stages of pandemic outbreaks, there is no warranted underlying assumption that someone has just "made an error" that will be exposed if we get someone new in to redo the math. As we will explain in this chapter, public disagreement could result from several factors, such as a lack of clarity about what is *really* going on in the early stages of a disease outbreak through to value disagreements about competing legitimate public goods in which hard trade-offs need to be made.

As a whole, "following the science" is an inadequate refrain for signalling good public health response. When the science is uncertain and emergent, the public is differentially impacted by the slate of intervention options, and the emergency situation requires expedient action, disagreement in public health will surely arise. Unpacking and untangling the competing interests, values, and inevitable trade-offs is difficult work, but necessary for ensuring inclusive, equitable, and effective public health interventions.

2. Public Health Science, Values, and Policy

Disagreements in public health tend to focus on methodological differences, but those practical disagreements touch on epistemological, ethical, and ontological divergences (Nijhuis and van der Maesen 1994). To start, public health science and practice encompass numerous approaches to health that can be characterised as "downstream", "midstream", and "upstream" (McKinlay 1998). The "downstream" focuses on immediate health needs of the populations. "Midstream", or intermediary, determinants of health are defined by material circumstances such as housing, employment, and food security. Finally, "upstream" encompasses structural determinants of health such as social status, income, racism, and exclusion. These diverse foci lead to ideological divisions within the field about how to best improve population health, as well as practical disagreements about how to allocate limited resources most impactfully – for example, do I spend limited resources on treating waterborne diseases or providing clean water? In an MSF (Médecins Sans Frontières) intervention in Uganda, they made the controversial decision to focus on the more mid-stream cause and provide clean water (controversial because we typically think of MSF as providing more direct medical care). Public health also encompasses numerous scientific disciplines, some of which are more amenable to observational methods and retrospective analyses while others prioritise prospective, controlled trials to test interventions. These methodological differences largely explained why experts disagreed on whether there was sufficient evidence to encourage or even mandate masks in non-health care settings during the COVID-19 pandemic (Greenhalgh et al. 2020). In the masking case, the disagreement was over whether randomised controls were required to show effectiveness, or if understanding

the mechanism of masking was sufficient (the Cowen and Cartwright chapter in this collection provide a more detailed discussion of these sort of disputes in the Evidence Based Policy movement).

Public health methodological debates also arise from philosophical differences within the field regarding the nature and scope of practice, which are broadly captured in what Susser and Susser (1996) described as "ecologism" versus "universalism". "Ecologism" pursues explanations that offer broad scope and expansive understanding of epidemiological events, while "universalism" privileges certainty and precision even at the expense of reductionism (Susser and Susser 1996). These philosophical commitments regarding the nature and scope of public health direct the more practical task of establishing causal associations in social epidemiology and public health and thereby warrant public health interventions. The classic interlocution between Bradford Hill (1965) and Fischer (1958) captures these differences, as do vigorous disagreements within cancer epidemiology between proponents of "black box" epidemiology, with its focus on the behaviour of individuals within a population (Savitz 1994), and mechanistic or molecular approaches (Peto 1984; Vandenbroucke 1998; Skrabanek 1994).

In addition, "eco-epidemiology" (cf. Krieger 1994; Susser and Susser 1996), described by Susser and Susser (1996) as initiating a paradigm shift from "chronic disease" epidemiology to "public health-oriented" epidemiology, brought together black box/behavioural and molecular approaches (thereby denying the presumed incompatibility between the two) *and* sociocultural dynamics into epidemiological inquiry. These philosophical disagreements in epidemiology implicate public health practice and policy, with the expansive view of epidemiology encouraging action over inaction and activism on a broad array of social determinants of health (Valles 2018). One notable example on the expansive side of the epidemiological spectrum is Nancy Krieger's suggestion that police killings ought to be classified as a public health issue of epidemiological concern (Krieger 2015). Meanwhile, the more conservative methodologists prefer limiting public health's proper domain of investigation in order to uphold scientific credibility[2] and to guard against government overreach and the medicalisation of social phenomena (see the exchange between Rothstein [2002, 2009] and Goldberg [2009]).

The promise to "follow the science" to fight the COVID pandemic was thereby misleading not only because the science is not settled, but also because science is not value-free. The epistemic uncertainty that shrouded COVID-19 pandemic response was due in part to the novelty of the virus and the "fast science" (Sarewitz 2020) that emerged in response. While "settled science" is better able to conceal the value-ladenness of science (that is, the semblance of agreement on epistemic claims is predicated on some degree of agreement on normative claims), the competing values were hyper visible to the so-called "armchair epidemiologists", the legions of captivated online news consumers, throughout the COVID-19 pandemic. Furthermore, public health is an appendage of government, whereby politics tangles with the science and values already in tension. Many public health officers struggled with public perception of their advisory roles to government; their critics challenged whether they were sufficiently arms-length from government and able to criticise or redirect government policy to be consonant with scientific advice (Meler 2021).

Any discussion of public health disagreement would be remiss not to highlight the public as stakeholders in public health practice and policy. Because our lives and well-being are impacted by public health decision making, members of the public may challenge and disagree with public health measures. Public health directives require buy-in from the public. Public

dissent and disagreement regarding most if not all COVID control methods (e.g., masks, school closures, lockdowns, vaccination, and border closures) may stem from the conviction that scientists and/or policy makers do not properly consider the needs and interests of the public (Goldenberg 2021). Those convictions are often exploited and manipulated by misinformation campaigns orchestrated by political opportunists (Bell and Gallager 2020; Dickinson 2021). Public interest is also as varied as the public is (academic discourse often prefers the plural "publics" to highlight this diversity), so democratic allowances for public participation in policy decision making is far from simple.

In all areas of public health practice and policy, science can never be sufficient to guide choices and trade-offs. Value judgements are at play in decision making regarding experimental design, interpretation of evidence, public health interventions, and policy advice (Douglas 2009). Policy can never be strictly "evidence-based" – by which we mean strict adherence to evidence produced by rigorous scientific methods (see the Cowen and Cartwright chapter in this collection for more detail of the evidence-based policy movement and its limits) – because it incorporates political priorities, economic constraints, and (hopefully) public input. Science can, for example, help quantify risks associated with school reopening on SARS-Cov-2 spread and help quantify the educational losses from continued closure (Kuhfeld et al. 2020), but it cannot determine whether to open or close schools. Making the decision requires prioritisation and trade-offs on social harms and benefits, considerations (or not) of equity, and normative thinking about what society ought to be and what its members owe each other. It is unlikely that full agreement will be met on which values should inform scientific practice and policy, but there are mechanisms for democratising the process and ensuring procedural justice (Fung 2003). Some examples include normalising transparent decision making by those in power, codifying accountability into the political process in order to keep power in check, and bringing in citizens' concerns, especially the voices of those most negatively impacted by the policies. While emergency situations sometimes necessitate expedience over participatory politics, this allowance must be used conservatively to protect the citizenry from unethical usurpation of power (Flood et al. 2020).

3. Epidemiological Models

The use of epidemiological modelling during COVID to predict disease transmission and justify public health interventions was important to policy decision making and highly contentious, and the disagreements capture the points of scientific, philosophical, and political disputes discussed so far. Epidemic modelling involves multiple decision points. This creates conjunctures at which estimates and value judgements must be made, introducing opportunities for disagreement (Harvard et al. 2021). Disagreements can be epistemic or value-based, or some combination of both – what philosophers of science describe as "mixed judgments" (Plutynski 2017; Alexandrova 2018). Epistemically, there can be contestation as to how to fill the gaps between what is currently known and unknown, using educated guesses to plump the difference (Northcott 2022: 8). The most notorious example of this is the CovidSim model, described in the now infamous "Report 9". Developed by Neil Ferguson and colleagues at Imperial College London, it was one of the main instigators of the United Kingdom's lockdown measures. Some of the parameters were based on actual data, such as household sizes and commuting distances, which had been reported as part of census procedures (Northcott 2022: 5). However, some important parameters needed to be based on educated guesses, such as what the infection fatality rate would be (Northcott

2022: 8). There was considerable uncertainty about what the correct model structure was and other relevant variables such as the distribution of hospitalisation and ICU admissions across different age groups. These "educated guess" parameters in the model have come under considerable philosophical scrutiny (see for instance the disagreements on the appropriateness of these assumptions between Winsberg, Brennan & Surprenant [2020], Van Basshuysen & White [2021], and Winsberg, Brennan & Surprenant [2021]). Some of the issues of concern in this philosophical literature are whether the values used were biased in favour of the modellers own concerns (Winsberg, Brennan & Surprenant 2020) and whether it is a problem that the predictions based on educated guesses were not realised (Northcott 2022).

Value-based disagreement can occur when decisions are made about which groups' interests should be prioritised in the analysis; deciding between issues typically affecting the young and the old is one such point. This is a value judgement because it is a decision about whose interests are the most important in our considerations. Sometimes there is a complicated combination of both epistemic and value-based considerations. One example is assessing the salience of race in the unfolding pandemic. Race turned out an extremely important factor, but its causal analysis was "conspicuously lacking" by Public Health England (Patel et al. 2020) and elsewhere (Thompson et al. 2021). This is what Harvard et al. (2021) describe as the representational challenge of model building, which is the question of what to represent in the model, how to represent it, and how to gather the information required for that representation (2–3). Each of these junctures represents a point of potential disagreement between scientists – I might suggest that red-headed children need to be included in the model, while you say that people of African-descent should be included, and still another colleague might argue that no distinguishing phenotypical features be included. The absence of race as an important causal factor to watch out for is a particularly conspicuous absence given the pre-existing literature arguing that we need to pay attention to race if we want to understand inequalities in health and disease outcomes (see for instance Epstein 2007; Krieger 2013).

Even deciding what should count as a "benefit" in an epidemiological model is a value-laden concept (Harvard et al. 2021: 4). For instance, if "survival" were to count as the only benefit worth paying attention to. This might seem glib – "of course survival matters!" you might say – but the exclusive focus on survival as the only benefit may mask the various quality of life impacts that one might experience from becoming ill and surviving. This has become increasingly salient as the consequences of cases of long-COVID become clearer over time. The decision over whether the "benefit" is mere survival, or survival with good ongoing health is a choice and one over which there can be disagreement.

At the start of COVID-19, time frames for developing models were unusually compressed and the information used to develop and test models was uncertain, creating epistemic deficiencies, at both the biological and the social level (Brooks-Pollock et al. 2021: 4). At the biological level, there were questions about modes of transmissibility. It was unclear whether the virus was airborne or transmissible via surface contact – i.e., there were disagreements between scientists about potential modes of transmission. The incubation period of the virus was also uncertain, and repeat cases of COVID-19 infections in individuals created questions about immunity (Crellen et al. 2021). At the social level, there was a lack of certainty about how individuals and groups would react to intervention (Reicher 2021). At the intersection between social demographic level and the level of the microscopic mechanisms of transmission is the reproduction rate (R_0), the rate at which those who are already infected infect those who are not.

The lack of reliable information can undermine modelling – "junk in, junk out" (this is not always the case, because even "untrue" models can be epistemically helpful when their false assumptions are "true enough" to make predictions about the target system (Northcott 2022)). This is salient in forms of modelling that aim at portraying the underlying mechanisms. If the aim is to model the mechanism of disease spread, and various portions of that mechanistic information are incomplete or incorrect, this can undermine the overall project. In other instances, with other methodological techniques, models can be used to fill informational gaps. This was the case in the Crellen et al. (2021) modelling effort to make headway on issues of immunity by using the best evidence at the time about the viral mechanism together with data about reported cases of reinfection to make projections about subsequent cases of reinfection and the implications for questions about immunity.

Given the number of points of indeterminacy and the role that estimation, judgement and values plays at these points, disagreement almost inevitably follows. This is not the kind of thing that can be resolved by mathematical adjustment, given that there are potential points of deep disagreement at play, such what counts as a "benefit". Once we recognise the inevitability of scientific disagreement this creates questions about how that should be managed. The Cowen and Cartwright chapter in this collection discuss the problem of what to do when experts disagree, and note that the philosophical fixes of social epistemologists, such as checking the credentials of the scientists and counting the number of experts on each side of a dispute, may not be appropriate. In the modelling case, the experts in the dispute are highly credentialed and it isn't clear what expert counting would look like here. In the UK context, the SPI-M-O (the Scientific Pandemic Influenza Group on Modelling, Operational sub-group) has procedures to maintain the disagreement, which they argue helps to prevent groupthink and foster constructive disagreement. This maintenance of internal scientific disagreement is in keeping with Jacob Stegenga's advice for keeping up scientific reliability in scenarios of requisite fast science, where he argues that maintaining internal criticism can be important when there isn't time for external criticism (like peer review) (Stegenga 2024 forthcoming). In the SPI-M-O case, they describe that they maintain this internal critical disagreement by considering at least two models at any time, on the grounds that this improves the quality of discussion and the overall quality of the final consensus report. Additionally, SPI-M-O has resisted against the temptation to quantitatively combine models. Instead, they favour what they describe as "[using] the modelling combined with understanding to generate the policy-relevant consensus" (Brooks-Pollock et al. 2021: 4).

Another point of potential contention is between models that are orientated towards the academy and those that are orientated towards policy. Epidemic modelling is almost always directed towards policy, and SPI-M-O are explicit that this is their target. Once it has been decided that a model should be directed towards policy, this introduces a new point of potential disagreement, which is the role that model should play in policy decision making. Here the tension is between whether the model is meant to predict what will happen or whether it is meant to influence the course of the pandemic, where success at influencing policy can diminish predictive effectiveness (Van Basshuysen et al. 2021). This retraces old philosophical ground on the issue of values in science policy advising. In particular, debates over whether the role of the science is to provide value-free facts to policy makers who will then do the value work as the representatives of society, or whether the role of science advising is inherently one of making value judgements (Rudner 1953; Steele 2012).

4. Lockdown

The most practical consequence of COVID-19 modelling projections were lockdown measures. Projections from the Imperial Model in March 2020 were that if no attempts at mitigation were made, 500,000 deaths would result in the United Kingdom and 2.2 million deaths in the United States (Fertguson et al. 2020). In the United Kingdom, lockdown quickly followed. This was described as "following the science".

In Section 3, it was demonstrated that the process of modelling disease outbreaks is replete with uncertainty, assumptions, disagreement, and value judgement. When the results of these models are translated into policy, there is an additional layer of value judgement and politicking. There is typically no direct route from the science to the public, rather it must go through the policy makers first. This is not to say that scientists do not try to directly influence public opinion, however, using social media and publishing open letters, for example, to argue the cases against and in support of lockdown practices during COVID-19 (see The Great Barrington Declaration [https://gbdeclaration.org/] and the John Snow Memorandum [https://www.johnsnowmemo.com/john-snow-memo.html; Alwan, Brugess and Ashworth 2020]).

Sometimes scientific advice must go through international organisations, such as the World Health Organisation, before it is interpreted by national governments for their country's contexts. WHO guidelines are intentionally overly broad. There are 194 WHO member states and no set of guidelines will be good for all contexts. In a WHO strategy update from April 2020 there is an explicit statement that their advice must be adjusted: "Every country should be implementing a comprehensive set of measures, calibrated to their capacity and context to slow down transmission and reduce mortality" (World Health Organisation 2020: 5).

Advice from the WHO on lockdowns in April 2020 was ambivalent. In the list of "global strategic objectives", "population level physical distancing measures" (5) is suggested as one intervention that countries should consider. However, in the same report, the difficulties of lockdown measures are also noted:

> For countries that have introduced widespread physical distancing measures and population-level movement restrictions, there is an urgent need to plan for a phased transition away from such restrictions in a manner that will enable the sustainable suppression of transmission at a low-level whilst enabling the resumption of some parts of economic and socio-economic benefit and epidemiological risk.
>
> *(World Health Organisation 2020: 3)*

Part of what is noteworthy about the above quote is that it indicates the tensions between competing aims, notably between curbing transmission and resuming social and economic life. There was substantial disagreement both nationally and sub-nationally about whether to lock down and how locked down to be.

A notable case of national-level disagreement with international lockdown norms was Sweden, which seemed to have no enforceable lockdown measures at all. The global press called it the "Swedish Exception" (The Economist 2020). Part of the explanation is that Swedish government initially lacked the legal powers to do this. The Swedish system limits governmental power in various areas and hands over decision making to members of governmental agencies with expertise in target domains. During the COVID-19 crisis, these

were a group of epidemiologists in the Swedish Public Health Agency (Folkhälsomyndigheten, FHM; Angner and Arrhenius 2020). Erik Angner and Gustaf Arrhenius (2020) argue that what we see in the Swedish case is a more literal following of the experts than in other countries, because the government lacked the powers to intervene. They note that of course there was disagreement, but that disagreement between experts is a normal part of the scientific process. The rationale for the FHM to pursue hard legally enforceable lockdown regulations was they wanted to "find implementation strategies that reduce the transmission of COVID-19 *and* reach other important health goals" (Kavaliunas et al. 2020: 599). Note that this provides us with another example of how different values are managed – the aim became one of valuing multiple public health goals instead of just COVID mitigation strategies. The Swedish government did pass an emergency bill to extend their powers in April 2020 under the Communicable Diseases Act, but without plans to make use of these new capacities (Irwin 2020: 7). Emergency powers were only intended as an additional tool if required. The commitment to maintaining a boundary between science and politics was maintained.

Lockdown measures are so contested at the local level because of competing needs and interests by different individuals. What protects some invariably harms others. Some are protected from the harm of infectious disease, while others are harmed by their exclusion from economic activity, which in some contexts is required for survival. The elderly are protected at the cost of the young's participation in educational and social activities (John 2020: 267). These are challenges globally, but they came into sharp focus in the South African case.

South Africa locked down early and substantially, with the army being called in to assist with enforcement (Bulled and Singer 2020). However, it wasn't clear that South Africa had taken their context seriously enough when balancing divergent interests. Alex Broadbent (2020) argues that COVID-19 is of particular risk to the elderly, but that South Africa has a disproportionately young population. More so, South Africans overall are very poor and need to work every day to stay alive. Thus, the balancing act between the interests of the young and the old that makes sense in the United Kingdom or the United States just doesn't work for South Africa. Broadbent's critique is compelling, but it excludes other factors that are relevant to the analysis. While South Africa's population is young, it is also a country with a substantial pre-existing disease burden, notably HIV/AIDS which diminishes immune function (Bulled and Singer 2020: 1234–1236). It also has a very over-stretched medical system. These two factors make South Africa especially vulnerable to a devastating COVID-19 outbreak, which arguably makes lockdown a reasonable measure. The South African case shows the complicated interaction between various sources of legitimate disagreement. Some are the familiar value disagreements experienced globally during the pandemic: how do we balance the interests of the young against those of the elderly? Some are disagreements about uncertain empirical matters: will the health of citizens be harmed more by poverty or by the COVID-19 pandemic?

5. Conclusion

While public health disagreements tend to focus on technical issues (method, data interpretation) and practice and policy, value judgements, both epistemic and social, frame those differences, as well as the competing interests of diverse stakeholders, including the diverse public. It is for this reason that reassurances to "follow the science" by political leaders oversimplified the difficulty of listening to public health advice and for managing the

COVID pandemic. In all areas of public health practice and policy, science can never be sufficient to guide choices and trade-offs. Instead, democratic, equitable, and inclusive norms need to complement public health research and practices.

Notes

1 By "lockdown", we mean a variety of practices that can be used during an infectious disease outbreak to lower or eliminate congregate gatherings and the resulting viral spread during infectious disease outbreaks. Lockdown measures range from shutting down non-essential businesses to school closures and stay-at-home orders.

2 A similar missive was expressed by Peto (1984) and Vandenbroucke (1998) regarding the imprecision of "black box" in contrast to the potential firmament of molecular-level causal claims.

References

Alexandrova, A. (2018) "Can the Science of Well-Being Be Objective?" *The British Journal for the Philosophy of Science* 69(2): 421–445.

Alwan, N. A., Rochelle Ann Brugess, and Simon Ashworth, et al. (2020) "Scientific consensus on the COVID-19 pandemic: We need to act now." *Lancet* 396 (10260): E71–E72.

Angner, E. and G. Arrhenius (2020) "The Swedish exception?" *Behavioural Public Policy Blog*, April 23. https://bppblog.com/2020/04/23/the-swedish-exception/.

Bell, B., and F. Gallager (2020) "Who is spreading COVID-19 misinformation and why?" *ABC News*, May 26. https://abcnews.go.com/US/spreading-covid-19-misinformation/story?id=70615995.

Bradford Hill, A. (1965) "The environment and disease: Association or causation?" *Proceedings of the Royal Society of Medicine* 58 (5): 295–300.

Broadbent, A. (2020) "Lockdown is wrong for Africa." *Mail and Guardian*, April 8. https://mg.co.za/article/2020-04-08-is-lockdown-wrong-for-africa/.

Brooks-Pollock, E., L. Danon, T. Jombart, and L. Pellis (2021) "Modelling that shaped the early COVID-19 pandemic response in the UK." *Philosophical Transactions of the Royal Society B* 376(1829): 1–8.

Bulled, N., and M. Singer (2020) "In the shadow HIV & TB: A commentary on the COVID epidemic in South Africa." *Global Public Health* 15(8): 1231–1243.

Christensen, D. (2007) "Epistemology of disagreement: The good news." *The Philosophical Review* 116(2): 187–217.

Crellen, T., L. Pi, E.L. Davis, T. M. Pollington, T. C. D. Lucas, D. Ayabina, A. Borlase, et al. (2021) "Dynamics of SARS-CoV-2 with waning immunity in the UK population." *Philosophical Transactions of the Royal Society B* 376(1829): 1–12.

Cross, R. (2021) "Will public trust in science survive the pandemic?" *Chemical & Engineering News* 99 (3): https://cen.acs.org/policy/global-health/Will-public-trust-in-science-survive-the-pandemic/99/i3.

Dickinson, T. (2021) "How the anti-vaxxers got red pilled." *Rolling Stone*, February 10. https://www.rollingstone.com/culture/culture-features/qanon-anti-vax-covid-vaccine-conspiracy-theory-1125197/.

Douglas, H. (2009) *Science, Policy and the Value-Free Ideal*. Pittsburgh, PA: University of Pittsburgh Press.

Epstein, S. (2007) *Inclusion: The Politics of Medical Difference*. Chicago, IL: University of Chicago Press.

Fertguson, N. M., D. Laydon, G. Nedjati-Gilani, N. Imai, K. Ainslie, M. Baguelin, S. Bhatia, et al. (2020) *Report 9: Impact of Non-Pharmaceutical Interventions (NPIs) to Reduce COVID-19 Mortality and Healthcare Demand*. London: Imperial College COVID-19 Response Team.

Fischer, R. A. (1958) "Cigarettes, cancer and statistics." *Centennial Review* 2 (1958): 151–166.

Flood, C. M. Vanessa McDonnell, Bryan Thomas, and Kumanan Wilson (2020) "Reconciling civil liberties and public health in the response to COVID-19." *FACETS* 5 (1): 887–898.

Goldberg, D. S. (2009) "In support of a broad model of public health: Disparities, social epidemiology and public health causation." *Public Health Ethics* 2: 70–83.

Goldenberg, M. J. (2021) *Vaccine Hesitancy: Public Trust, Expertise, and the War on Science*. Pittsburgh, PA: University of Pittsburgh Press.
Greenhalgh, T., M. B. Schmid, T. Czypionka, D. Gruer, and L. Bassler (2020) "Face masks for the public during the COVID-19 crisis." *BMJ* 1–4.
Harvard, S., E. Winsberg, J. Symons, and A. Adibi (2021) "Value judgments in a COVID-19 vaccination model: A case study in the need for public involvement in health-orientated modelling." *Social Science and Medicine* 1–6.
Ioannidis, J. P. A. (2020) "A fiasco in the making? As the coronavirus pandemic takes hold, we're making decisions without reliable data." *Stat News*, March 17. https://www.statnews.com/2020/03/17/a-fiasco-in-the-making-as-the-coronavirus-**pandemic**-takes-hold.
Irwin, R. E. (2020) "Misinformation and de-contextualization: International medial and reporting on Sweden and COVID-19." *Globalization and Health* 16: 1–12.
John, S (2017) "Epistemic trust and the ethics of science communication: Against transparency, openness, sincerity and honesty." *Social Epistemology* 32(2): 75–87.
John, S. (2020) "The ethics of lockdown: Communication, consequences, and the separateness of persons." *Kennedy Institute of Ethics Journal* 30(3): 265–289.
Kavaliunas, A., Pauline Ocaya, Jim Mumper, Isis Lindfeldt, and Mattias Kyhlstedt (2020) "Swedish policy analysis for Covid-19." *Health Policy and Technology* 9(4): 598–612.
Krieger, N. (1994) "Epidemiology and the web of causation: Has anyone seen the spider?" *Social Science & Medicine* 39: 887–903.
Krieger, N. (2013) *Epidemiology and the People's Health: Theory and Context*. Oxford: Oxford University Press.
Krieger, N. (2015) "Police killings, political impunity, racism and the people's health." *Harvard Public Health Review* 3: 1–3.
Kuhfeld, M. et al. (2020). "Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement" *Educational Researcher* 49(8): 549–565.
Lipsitch, M. (2020) "Marc Lipsitch We know enough now to act decisively against Covid-19. Social distancing is a good place to start." *Stat News*, March 18. https://www.statnews.com/2020/03/18/we-know-enough-now-to-act-decisively-against-covid-19/.
McKinlay, J. B. (1998) "Paradigmatic obstacles to improving the health of populations–implications for health policy. 1." *Salud Publica de Mexico* 40 (4): 369–379.
Meler, B. (2021) "'It's a minefield': How public trust in Canada's top doctors is undermined by politics amid the COVID-19 pandemic." Yahoo Canada, March 11. https://ca.news.yahoo.com/covid19-canada-trust-doctors-politicans-cmohs-120047289.html?soc_src.
Nijhuis, H. G. J., and Laurent J. G. van der Maesen (1994) "The philosophical foundations of public health: An invitation to debate." *Journal of Epidemiology & Community Health* 48: 1–3.
Northcott, R. (2022) "Pandemic modeling, good and bad." *Philosophy of Medicine* 3(1): 1–20.
Patel, Parth, L. Hiam, A. Sowemimo, D. Devakumar, and M. McKee (2020) "Ethnicity and covid-19." *BMJ* 369: 1–2.
Peto, R. (1984) "The need for ignorance in cancer research." In *The Encyclopedia of Medical Ignorance*, Ronald Duncan and Miranda Weston-Smith (Eds). Oxford: Pergamon Press, 129–133.
Plutynski, A. (2017) "Safe or Sorry? Cancer screening and inductive risk." In *Exploring Inductive Risk: Case Studies of Values in Science*. Kevin Elliott and Ted Richards, eds. Oxford University Press. 149–169.
Reicher, S. (2021) "Human behaviour: what scientists have learned about it from the pandemic." *The Conversation*, July 1. https://theconversation.com/human-behaviour-what-scientists-have-learned-about-it-from-the-pandemic-163666.
Rothstein, M. A. (2002) "Rethinking the meaning of public health." *Journal of Law, Medicine & Ethics* 30: 144–149.
Rothstein, M. A. (2009) "The limits of public health: A response." *Public Health Ethics* 2: 84–88.
Rudner, R (1953) "The scientist qua scientist makes value judgments." *Philosophy of Science* 20(1): 1–6.
Sarewitz, D. (2020) "Slow science, fast science." *Issues in Science and Technology* 36 (3): 18–19.
Savitz, D. A. (1994) "In defense of black box epidemiology." *Epidemiology* 5: 550–552.
Science Media Centre (2020) "Expert reaction to paper using an RCT to assess mask use as a public health measure to help control SARS-CoV-2 spread (DANMASK-19)." *Science Media Centre*,

November19.https://www.sciencemediacentre.org/expert-reaction-to-paper-using-an-rct-to-assess-mask-use-as-a-public-health-measure-to-help-control-sars-cov-2-spread-danmask-19/.
Sidgwick, H. (1981/1907) *The Methods of Ethics* (Hackett first edition, unabridged republication of the seventh (1907) Macmillan edition). Cambridge: Hackett.
Skrabanek, P. (1994) "The emptiness of the black box." *Epidemiology* 5: 553–555.
Steele, K. (2012) "The scientist qua policy advisor makes value judgments." *Philosophy of Science* 79(5): 893–904.
Stegenga, J. (2024) "Fast science." *British Journal of Philosophy of Science*. https://doi.org/10.1086/729617.
Susser, Mervyn, and Ezra Susser (1996) "Choosing a future for epidemiology: I. Eras and paradigms." *American Journal of Public Health* 86: 668–673.
The Economist (2020) "The Swedish exception: Why Swedes are not yet locked down." *The Economist*, April 4.
Thompson, E., Rojiemiahd Edjoc, Nicole Atchessi, Megan Striha, Imran Gabrani-Juma, and Thomas Dawson (2021) "COVID-19: A case for the collection of race data in Canada and abroad." *Canada communicable disease report (CCDR)* 47(7/8): 300-304.
Valles, S. (2018) *Philosophy of Population Health*. New York: Routledge.
Van Basshuysen, P. and White, L. (2021) "Were lockdowns justified? A return to the facts and evidence." *Kennedy Institute of Ethics Journal* 31(4): 405–428.
Van Basshuysen, P., L. White, D. Khosrowi, and M. Frisch (2021) "Three ways in which pandemic models may perform a pandemic." *Erasmus Journal for Philosophy and Economics* 14(1): 110–127.
Vandenbroucke, J. P. (1998) "Is "The causes of cancer" a miasma theory for the end of the twentieth century?" *International Journal of Epidemiology* 17: 708–709.
Winsberg, E., J. Brennan, and Chris Surprenant (2020) "How government leaders violated their epistemic duties during the SARS-CoV-2 crisis." *Kennedy Institute of Ethics Journal* 30(3–4): 215–242.
Winsberg, Eric, Jason Brennan, and Chris Surprenant (2021) "This paper attacks a strawman but the strawman wins: A reply to van Basshuysen and White." *Kennedy Institute of Ethics Journal* 31(4): 429–446.
World Health Organisation (2020) *COVID-19 Strategy Update*, 14 April 2020. Geneva: World Health Organisation.